

1 Improvements to loudspeaker driver assemblies

2
3 The present invention relates improvements to loudspeaker
4 driver assemblies and in particular to driver assemblies
5 with retaining elements for panel loudspeakers.

6
7 Panel loudspeakers are becoming increasingly popular due
8 to their low profile, practicality, low cost and
9 improving sound quality.

10
11 Various constructional arrangements are available on the
12 market, the majority of which include a driver assembly
13 having a transducer for converting an electrical current
14 into mechanical, pistonic movement. For distributed mode
15 acoustic radiators, a panel has several nodes of
16 movement. The rigid attachment of the transducer
17 components to the panel alters the behaviour of the
18 panel. In addition, the majority of the available
19 arrangements require secure, permanent attachment in
20 order to achieve adequate acoustic response. Although
21 several attempts have to solve the above problems have
22 been made, they have limitations in their acoustic
23 response and are relatively expensive to produce.

24

1 It would therefore be desirable to provide an improved
2 driver assembly that obviates or at least mitigates one
3 or more of the drawbacks of the prior art.

4

5 According to a first aspect of the invention there is
6 provided a driver assembly for a panel loudspeaker the
7 driver assembly comprising a voice coil, a magnet
8 assembly, and a moulded retaining element for retaining
9 the magnet assembly with respect to the voice coil,
10 wherein the moulded retaining element defines a first
11 surface adapted to be coupled to panel forming an
12 acoustic radiator.

13

14 Preferably, the moulded retainer consists of an elastomer
15 material.

16

17 Preferably, the assembly further comprises a
18 substantially rigid planar member attached to the voice
19 coil, the planar member being disposed between the voice
20 coil and said first surface.

21

22 According to a second aspect of the invention there is
23 provided a driver assembly for a panel loudspeaker
24 comprising a voice coil, a magnet assembly, a retaining
25 element for retaining the voice coil with respect to the
26 magnet assembly, wherein the retaining element consists
27 of an elastomer, and defines a first surface adapted to
28 be coupled to a panel forming acoustic radiator.

29

30 Preferably, the elastomer is a hydrogel.

31

32 According to a third aspect of the invention there is
33 provided a driver assembly for a panel loudspeaker

1 comprising a voice coil, a magnet assembly, a
2 substantially rigid planar member, a retaining element
3 for retaining the voice coil with respect to the magnet
4 assembly, wherein the retaining element defines a first
5 surface adapted to be removably coupled to a panel
6 forming an acoustic radiator, and the substantially rigid
7 planar member is attached to the voice coil and is
8 disposed between the voice coil and said first surface.

9
10 Preferably, the retaining element consists of a hydrogel.
11

12 Optionally, the retaining element consists of silicone.

13
14 The retaining element may consist of a material having a
15 Shore A hardness in the range 0 to 20.

16
17 The retaining element may consist of a material having a
18 Shore A hardness in the range 5 to 15.

19
20 The retaining element may consist of a material having a
21 Shore A hardness of approximately 10.

22
23 Preferably, the retaining element functions to retain the
24 voice coil and the magnet assembly in a spatially
25 separated relationship.

26
27 Preferably, the retaining element consists of a single
28 moulded element.

29
30 Preferably, the first surface is adapted to be removably
31 coupled to the panel forming the acoustic radiator.

32

1 Preferably, the magnet assembly comprises an axially
2 extending central portion defining a first pole of a
3 permanent magnet, a radially extending portion coupling
4 the central portion to an axially extending magnetic
5 shroud, the shroud defining a second pole of the
6 permanent magnet, wherein the central portion and the
7 shroud define a flux space therebetween.

8

9 More preferably, the voice coil extends into the flux
10 space. The flux space may be annular.

11

12 Preferably, the retaining element comprises a disc
13 defining the first surface. More preferably, the
14 retaining element comprises a wall upstanding from an
15 opposing surface of the disc.

16

17 Preferably, a volume defined by the retaining element
18 accommodates the magnet assembly and the voice coil.

19

20 Preferably, the planar member is mounted adjacent said
21 opposing surface of the disc.

22

23 Preferably, the wall has an inner diameter and an outer
24 diameter, and the disc has a diameter greater than said
25 outer diameter such that the disc defines a flange around
26 the wall.

27

28 Preferably, said opposing surface of the disc is provided
29 with one or more continuous ridges extending around the
30 wall. More preferably, the continuous ridges are
31 concentric with the wall.

32

1 Preferably, the wall is provided with a radially
2 extending flange for engaging the magnet assembly.

3

4 Preferably, the outer diameter of the wall decreases in a
5 direction away from the disc. The retaining element is
6 therefore partially frusto-conical in shape.

7

8 According to a fourth aspect of the invention there is
9 provided a retaining element for a panel loudspeaker
10 driver assembly comprising a disc defining a first
11 surface adapted to be removably coupled to an acoustic
12 radiator, and a wall upstanding from an opposing surface
13 of the disc and accommodating a voice coil and a magnet
14 assembly in a spatially separated relationship.

15

16 According to a fifth aspect of the invention there is
17 provided a method of mounting an acoustic radiator of a
18 panel loudspeaker comprising the steps of:

19 locating a voice coil and a magnet assembly in a
20 moulded retaining element, and;
21 removably attaching a surface defined by the moulded
22 retaining element to a panel forming the acoustic
23 radiator.

24

25 Preferably, the surface is removably attached to the
26 panel by being placed in contact with the panel.

27

28 More preferably, the surface is removably attached to the
29 panel without auxiliary fixing means.

30

31 Preferably, the surface has adhesive properties.

32

1 According to a sixth aspect of the invention there is
2 provided a method of manufacturing a driving assembly for
3 a panel loudspeaker, the method comprising the steps of:
4 forming a retaining member by injection moulding,
5 and;
6 assembling a voice coil and magnet assembly in the
7 retaining member.

8
9 There will now be described, by way of example only,
10 various embodiments of the invention with reference to
11 the accompanying drawings of which:

12
13 Figure 1 is a perspective sectional view of a driver
14 assembly in accordance with an embodiment of the
15 invention, having a portion removed to display
16 internal components;

17
18 Figure 2 is a cross-sectional view of the driver
19 assembly of Figure 1;

20
21 Figure 3 is a perspective view of the driver
22 assembly of Figures 1 and 2;

23
24 Figure 4 is a perspective sectional view of a driver
25 assembly in accordance with an alternative
26 embodiment of the invention, having a portion
27 removed to display internal components.

28
29 Referring to Figures 1 to 3 of the drawings, there is
30 shown a driver assembly, generally depicted at 10,
31 comprising a transducer 12 and a retaining element 13.
32 The transducer 12 is of the moving-coil type, and
33 includes a voice coil 14 and a magnet assembly 15.

34

1 The voice coil 14 consists of a hollow cylinder with a
2 coil of conducting material secured thereto. Electrical
3 connectors 16 are provided to provide electrical contact
4 with a current source (not shown) via wires 17. The
5 device is driven by alternating current (AC), and
6 preferably has standard loudspeaker impedance
7 characteristics (4, 6 or 8 Ohm) with power handling in
8 the range from 0.5 - 100W.

9

10 The magnet assembly 15 comprises a substantially
11 cylindrical metallic outer sheath 18, and a circular
12 metallic back plate 20. The sheath 18 is provided with
13 an inwardly extending lip 19 of lesser inner diameter
14 than the main body of the sheath. Centrally mounted in
15 the back plate 20, internally to the sheath 18, is a
16 cylindrical permanent magnet 21, mounted to the back
17 plate 20 at one of its ends. On the opposing (lower) end
18 of cylindrical magnet 21, there is provided an axially
19 extending metallic portion 22. The axially extending
20 metallic portion 22 comprises a frusto-conical portion
21 23, with outer diameter decreasing in a direction moving
22 away from the back plate 20. The axially extending
23 metallic portion 22 at its free end has a cylindrical
24 portion 24 with greater outer diameter such that a flange
25 is defined.

26

27 The geometry of the magnet assembly 15 is such that an
28 annular air space 26 separates the inwardly extending lip
29 19 and the cylindrical portion 24. The cylindrical
30 portion 22 defines one pole of a permanent magnet (shown
31 as N), and the inwardly extending lip 19 defines the
32 opposing pole of a permanent magnet (shown as S).

1 Magnetic flux is therefore concentrated in the annular
2 region 26.

3

4 The voice coil 14 is securely mounted to a rigid planar
5 pad 28, substantially concentrically with the pad 28.

6

7 The components of the transducer 12 are accommodated in
8 the retaining element 13, which is moulded from an
9 elastomeric material, which is preferably a silicone
10 hydrogel. In this example, the material has a Shore A
11 hardness of approximately 10. It has been found that
12 materials having a Shore A hardness in the range 5 to 15
13 are particularly suitable, although materials with Shore
14 A hardness in the range 0 to 20 could also be used
15 effectively.

16

17 The retaining element 13 comprises a substantially planar
18 disc 30 defining a planar (front) surface 31, and a
19 circular surrounding wall 32 upstanding from an opposing
20 (back) surface 33 of the disc.

21

22 The circular surrounding wall 32 has a varying outer
23 diameter that decreases in a direction moving away from
24 the disc 30. The retaining element therefore has a
25 frusto-conical shape.

26

27 The disc 30 has a greater diameter than that of the
28 surrounding wall 32, such that the disc defines a flange
29 40 around the wall. The opposing (back) surface 33 is
30 provided with a pair of continuous concentric circular
31 ridges 42, located around the surrounding wall 32. The
32 ridges 42 allow an increased degree of axial flexibility
33 of the disc, while retaining a certain amount of

1 stiffness against flexing about diametric lines and/or
2 chords.

3

4 The internal diameter of the retaining element 13 differs
5 at different axial positions of the element in order to
6 accommodate the different components of the transducer.
7 The rigid pad 28 is placed adjacent the opposing surface
8 33 of the disc, approximately concentrically with the
9 disc and with the internal volume defined by the
10 surrounding wall 32. The rigid pad is thus disposed
11 between the voice coil and the disc 30. The rigid pad 28
12 has a diameter less than the outer diameter of the
13 surrounding wall 32, but greater than the inner diameter
14 of the main portion 32a of the surrounding wall. A
15 shallow annular slot 34 is therefore provided to
16 accommodate the rigid pad 28. Preferably the depth and
17 diameter of the annular slot 34 corresponds closely to
18 the thickness and diameter of the of the rigid pad 28, in
19 order that the retaining element holds the rigid pad
20 reasonably tightly.

21

22 Behind the rigid pad 28 (moving in a direction from the
23 front surface 31 of the disc to the back plate 20), the
24 surrounding wall is provided with a portion of decreased
25 inner diameter, such that an inwardly extending ring 36
26 is defined. The inner diameter of the ring 36
27 corresponds to the outer diameter of the voice coil 14.

28

29 The inner diameter of the main portion 32a of the
30 surrounding wall 32 corresponds to the outer diameter of
31 the sheath 18 of the magnet assembly 15. The magnet
32 assembly 15 and the voice coil 14 are held by the
33 retaining element in an aligned, spatially separated

1 relationship. The positioning of the components is such
2 that the voice coil extends axially into the annular
3 space 26 in the magnet assembly. The coil is therefore
4 located in the region of concentrated magnetic flux.

5

6 At the back end of the surrounding wall 32, an inwardly
7 extending ring 38 is provided to engage with a
8 circumferential portion of the back plate. A central
9 area of the back plate is exposed, and may protrude
10 through the aperture defined by the inwardly extending
11 ring 38. The aperture provides access to the internal
12 components of the driver assembly. In conjunction with
13 the physical properties of the hydrogel material, the
14 geometry of the retaining element 13 allows the retaining
15 element to be temporarily stretched to allow assembly of,
16 access to and removal of the transducer components.

17

18 In use, the front surface 31 of the disc 30 is coupled to
19 a panel 44 to be used as an acoustic radiator. The
20 choice of a hydrogel material for the disc reduces the
21 reliance on auxiliary fixing means, such as a mechanical
22 fixing, bonding or adhesive. The planar front surface of
23 hydrogel material has inherent adhesive properties
24 arising from the chemical make up of the material. This
25 adhesion is adequate for removably attaching the driver
26 assembly a wide range of rigid panels without using an
27 auxiliary fixing mechanism or agent. The driver assembly
28 will remain securely attached to the panel during use,
29 with excellent acoustic coupling. After use, or if the
30 position of the driver assembly is to be changed, it can
31 be removed from the panel by simply peeling or pulling
32 the driver assembly away from the panel. The panel can
33 be repositioned immediately in the same manner.

1
2 When coupled to any of a variety of panels, the driver
3 assembly to produce a distributed mode speaker with good
4 acoustic response characteristics. Since the coil 14 is
5 located in the annular space 26, at which the magnetic
6 flux of the magnet assembly 15 is concentrated, the
7 application of an alternating current to the coil imparts
8 a relative axial movement between the coil and the
9 magnet. The retaining element 13 limits the axial
10 expansion of the driver assembly, in a rearward
11 direction, and thus the relative movement manifests
12 itself as an axial movement of the voice coil 14. The
13 voice coil imparts movement to the rigid pad 28, which
14 transmits the mechanical movement to the panel 44 via the
15 disc 30.

16
17 The geometry of the retaining element is such that it
18 directs the major mechanical movement to the area where
19 there is contact with the panel 44, improving the
20 movement in this side of the drive assembly, and
21 minimising or effectively cancelling the movement on the
22 back side of it.

23
24 Figure 4 shows a driver assembly in accordance with an
25 alternative embodiment of the invention. This embodiment
26 is similar to that shown in Figures 1 to 3, although it
27 has constructional and geometrical differences.

28
29 Figure 4 shows a driver assembly, generally depicted at
30 50, comprising a voice coil 54, a magnet assembly 55 and
31 a retaining element 53.

1 The magnet assembly 55 comprises a metallic outer sheath
2 58, and a circular metallic back plate 60. The sheath 56
3 has an outwardly extending rim 58 which separates
4 frusto-conical back portion 57 and an inwardly extending
5 lip 59 of lesser inner diameter than the main body of the
6 sheath. Centrally mounted in the back plate 60,
7 internally to the sheath 56, is a cylindrical permanent
8 magnet 61, mounted to the back plate 60 at one of its
9 ends. On the opposing (lower) end of cylindrical magnet
10 61, there is provided an extending metallic portion 62
11 with a shaped rim 64 defining a flange.

12

13 As with the embodiment of Figures 1 to 3, the geometry of
14 the magnet assembly 55 is such that an annular air space
15 in which magnetic flux is concentrated.

16

17 Also as before, the voice coil 54 is securely mounted to
18 a rigid planar pad 68, substantially concentrically with
19 the pad 68, and the components are retained in the
20 elastomeric retaining element 53. The retaining element
21 53 comprises a substantially planar disc 70 defining a
22 planar (front) surface, and a circular surrounding wall
23 72 upstanding from an opposing (back) surface of the
24 disc.

25

26 The retaining element, which preferably is a silicone
27 material as described with reference to Figures 1 to 3,
28 fits over and around the back portion 57 of the sheath
29 58. In this example, the rim 58 is received in a groove
30 in the retaining element. The cooperation of the rim and
31 groove assists in the maintaining the components in an
32 appropriate spatial relationship.

33

1 In contrast to the embodiment of Figures 1 to 3, the
2 magnet assembly is provided with a bore 75 extending
3 through the back plate 60, the magnet 61 and the metallic
4 portion 62. In this example, the bore is concentric with
5 the other components of the apparatus. Electrical
6 connections 76 to the voice coil 54 to pass through the
7 bore and out to the audio apparatus providing the audio
8 signal.

9

10 The principles of operation of the embodiment of Figure 4
11 are the same as those described with reference to Figure
12 1 to 3.

13

14 One function of the hydrogel retaining element is the
15 transmission of energy from voice coil vibrations, which
16 have relatively large amplitude, to panel vibrations of
17 relatively small amplitude across a bigger surface area
18 of the panel. This is facilitated by the provision of a
19 disc to give a large contact area between the driver
20 assembly and the panel. Consequently, the driver
21 assembly turns a larger proportion of the panel into a
22 loudspeaker and therefore produces a high quality sound
23 in the high, medium and low frequency ranges. Compared
24 with prior art arrangements, the present invention
25 performs particularly well in the mid- to low-frequency
26 ranges.

27

28 In addition, the retaining element provides a flexible
29 connection between the transducer and the panel, without
30 restricting the vibrations of the panel in the same
31 manner as many prior art systems.

32

1 In accordance with one embodiment of the invention, the
2 driver assembly is manufactured by:
3 (i) forming a retaining element from a hydrogel
4 by an injection moulding process
5 (ii) assembling a transducer from a magnet
6 assembly and a voice coil with the retaining
7 element.

8

9 The rigid pad 28 could be inserted into the retaining
10 element after injection moulding, or alternatively the
11 injection moulding could take place around a pre-
12 positioned rigid pad.

13

14 The present invention in its various aspects provides
15 numerous advantages over the prior art arrangements.

16

17 Firstly, the flexibility of the hydrogel transmits
18 mechanical movement of the transducer to the panel
19 without constraining its own modes of movement, which
20 ensures an accurate sound fidelity.

21

22 The flexible attachment allows movement at the contact
23 point between the driver assembly and the panel
24 mitigating panel stress and damage.

25

26 The assembly avoids the need for a spider for mounting
27 the magnet assembly centrally with respect to the voice
28 coil.

29

30 The retaining element aligns the movement of the voice
31 coil, and minimises the stress to the coil and rattling
32 caused by misalignment.

33

1 The retaining element aids heat dissipation and protects
2 the panel from overheating.

3

4 The driving assembly is compatible with a wide range of
5 rigid panels, due to the avoidance of bonding the
6 transducer to the panel.

7

8 The improved alignment of the transducer parts allows
9 manufacture of the transducer with a small annular space
10 between the voice coil and the magnet assembly, improving
11 transducer efficiency.

12

13 Due to the non-bonded attachment of the transducer to the
14 panel, the weight of the panel is not supported by the
15 drive assembly.

16

17 The driver assembly has the ability of produce high
18 quality sound at frequencies of between 50 to 18000Hz
19 using only one transducer.

20

21 The retaining element keeps all component parts together,
22 but at the same time gives some flexibility to the
23 structure of the product.

24

25 The driver assembly has improved load bearing
26 characteristics.

27

28 The driver assembly and retaining element of the present
29 invention is able to function on a wide range of surfaces
30 such as foam tiles, display boards, metal, glass and
31 plastics. The properties and the manufacturing process
32 of the hydrogel render the unit flexible due to the way
33 it is fixed to a panel within seconds and can be attached

1 and re-attached without damage to the panels/displays,
2 and without an auxiliary fixing agent or mechanism.

3

4 The technology can be used wherever space is limited, or
5 external access to transducer components is to be
6 avoided. The flexibility of the assembly gives rise to
7 numerous applications of the technology as follows:

8

- 9 • Audio/visual products.
- 10 • Ceiling tile installations.
- 11 • Hifi manufacturers/retailers.
- 12 • Mobile telephones.
- 13 • Boating and leisure industries.
- 14 • Vandal-proof requirements and security.
- 15 • Clean rooms.
- 16 • Military.
- 17 • ATMs, interactive kiosks.
- 18 • Mobile audio/concerts.

19

20 Particular applications to audio systems in public areas
21 are envisaged, for example to advertising displays with
22 audio capability. The driver assembly may be mounted to
23 a rear surface of a display board, and connected to a
24 source of audio data such as a combined MP3 player and
25 amplifier. A proximity detector, such as an infrared
26 detector, may be provided to activate the system in
27 response to an indication that a person is in the
28 vicinity of the display.

29

30 It will be appreciated by one skilled in the art that
31 various modifications and improvements could be made
32 within the scope of the invention herein intended.